

FIRST SEMIANNUAL (TYPE II) PROGRESS REPORT FOR OHIO-ERTS
DATA USER PROGRAM (JULY-DECEMBER 1972)

Project Title: Relevance of ERTS-1 to the State of Ohio

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Preface

The objective of this contract is to determine how state government can benefit from orbital surveys such as ERTS-1. The program is multidisciplinary and involves the experimental evaluation of ERTS-1 imagery and data-relay capabilities to environmental quality, agricultural and forestry, and geographic (land-use) applications in Ohio. Initial ERTS-1 photographs are being analyzed in combination with aircraft and ground-truth photographic and radiometric data for five Ohio study sites. Participation in the DCS experiment involves the use of a single data collection platform for demonstrating the potential of satellite relays in state environmental quality monitoring networks. The statewide program involves the cooperation of the Departments of Natural Resources, Health and Public Works, Economic and Community Development (Lead Department), Highways, the Environmental Protection Agency, and The Ohio State University. Prime technical subcontractor is the Battelle Columbus Laboratories.

During the first six months of project effort, significant progress has been made toward developing an effective program for collecting, analyzing, and evaluating ERTS-1 data for Ohio. As programmed, DCS efforts are proceeding at a lower priority pace. The extent of state personnel interests and participation in the Ohio-ERTS program has been encouraging and preliminary analyses of the initial ERTS imagery of Ohio have demonstrated the potential usefulness of such imagery for detecting, mapping, and inventorying strip-mined land, detecting sources of air pollution, and mapping Ohio's land for long-term, land-use planning.

I. INTRODUCTION

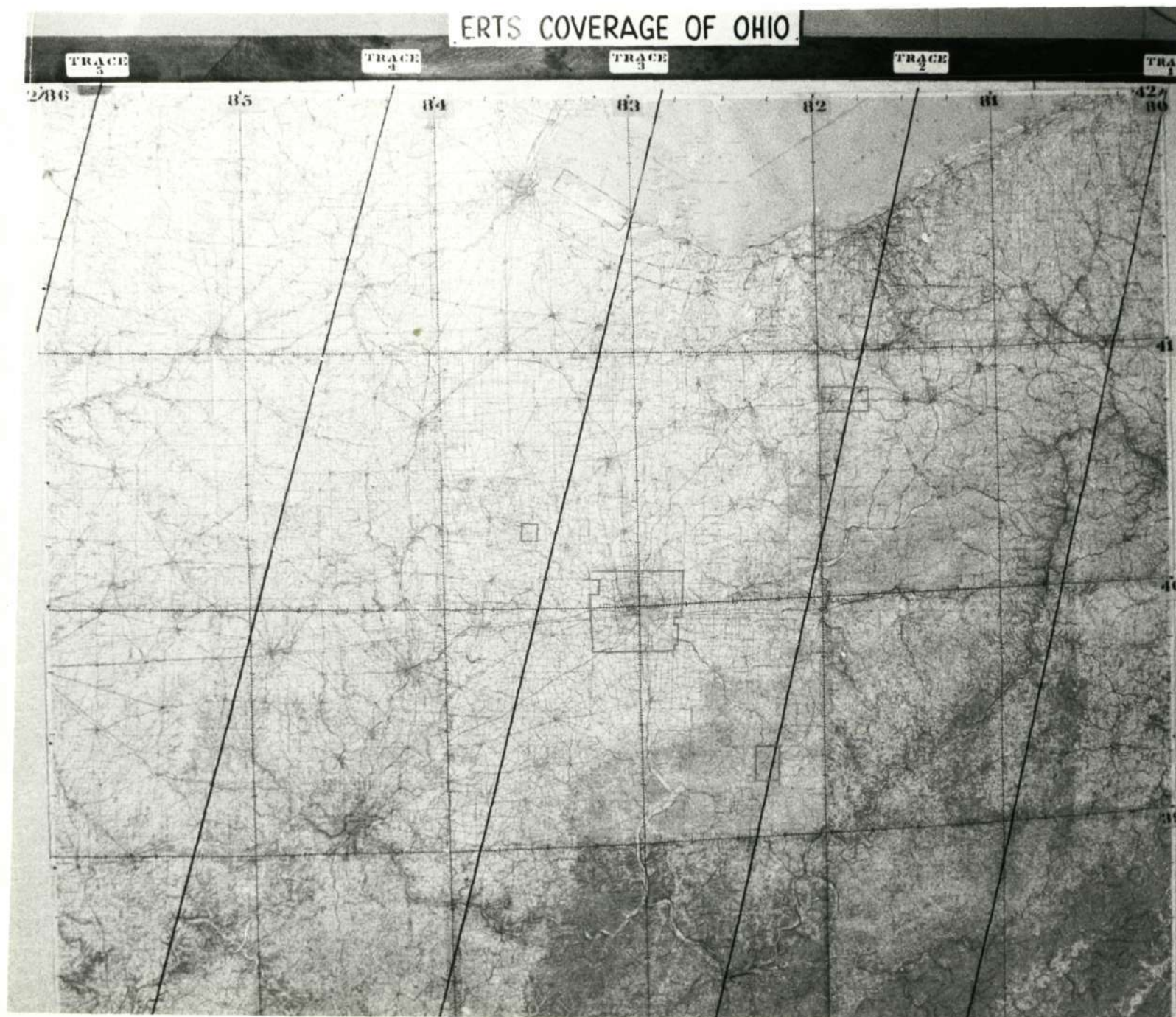
This report represents the first semiannual (Type II) report prepared under the Ohio-ERTS Data Users Contract, NAS5-21782. The report summarizes the status and progress of this program from July 1 through December 31, 1972.

The main discussion that follows is presented in the same format used to report on bimonthly program progress and thus treats specifically data collection, data analysis, DCS, and data utility assessment activities. The status of these activities are reviewed in terms of accomplishments, problems, and plans. Also, as in the Type I progress reports, a section devoted to significant results is provided, as is a miscellaneous section describing other project developments of potential sponsor interest such as press releases, meeting attendance, etc.

II. DATA COLLECTION

A. ERTS-1 Data

Unfortunately, an unusually high percentage of cloud cover has existed over Ohio since ERTS-1 was launched on July 23, 1972. However, usable ERTS photography has been obtained primarily for eastern Ohio and made available to the project starting in October 1972. Initial scenes of value were obtained on the ERTS-1 pass of August 21, 1972, and intermittent Ohio imagery obtained up to the November 20, 1972, overflight has been received. Figure 1 shows the ERTS orbital traces required for complete coverage of Ohio. Table I correlates dates of ERTS-1 orbital traces over Ohio with data received. Dates underlined indicate no data received. To date some data have been received for about half of ERTS-1 Ohio overflights since August 21, 1972. Table II shows the availability and quality (relative to cloud cover) of ERTS-1 imagery by study sites processed to date; whereas Table III describes the coverage and quality of ERTS-1 imagery available according to the orbital traces over Ohio.



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Figure 1. ERTS-1 Orbital Traces Over Ohio.

TABLE I. TRACE SUMMARY OF ERTS-1
DATA RECEIVED ON OHIO

Date, 1972	Trace				
	1	2	3	4	5
Aug.	21	22	<u>23</u> *	24	25
Sep.	8	9	<u>10</u>	<u>11</u>	<u>12</u>
Sep.	26	<u>27</u>	28	<u>29</u>	<u>30</u>
Oct.	14	15	<u>16</u>	17	<u>18</u>
Nov.	<u>1</u>	<u>2</u>	3	<u>4</u>	<u>5</u>
Nov.	<u>19</u>	20**	--	--	--

* Underlined dates indicate no data received.

** Most recent ERTS-1 photography received
as of December 31, 1972.

TABLE II. STATUS AND QUALITY* OF OHIO-ERTS
DATA RECEIVED BY STUDY SITE AS OF
DECEMBER 31, 1972

Area	Traces	Date, 1972	Time	Quality
Cleveland and Wooster	2	Aug. 22	15405	Poor
		Sep. 9	15411	Poor
		Oct. 15	15413	Very poor
		Nov. 20	15420	Very poor
Columbus	2 & 3	Aug. 22	15414	Very poor
		Sep. 9	15414	Fair
		Oct. 15	15415	Very good
		Nov. 3	15480	Very good
East Liberty	3	Nov. 3	15480	Very good
Ottawa	3	Nov. 3	15473	Very good
Zaleski	2	Aug. 22	15414	Very poor
		Sep. 9	15420	Good
		Oct. 15	15422	Very good

* Quality relates to cloud cover conditions over study sites.

TABLE III. COVERAGE AND QUALITY OF ERTS-1 DATA
AVAILABLE BY ORBITAL TRACE OVER OHIO

Date (1972)	Time	Area	Quality Comments*
<u>TRACE 1</u>			
Aug. 21	15353	Eastern Lake Erie	Very good
Aug. 21	15354	Eastern Ohio and Pennsylvania	Very good
Aug. 21	15361	SE Ohio and West Virginia	Very good
Sep. 8	15355	NE Ohio and Pennsylvania	Very poor
Sep. 8	15362	SE Ohio and 90% West Virginia	Poor
Sep. 26	15361	SE Ohio and 90% West Virginia	Poor
Oct. 14	15354	NE Ohio and Youngstown (Excellent); Lake Erie (Poor)	
Oct. 14	15361	Eastern Ohio	Good
Oct. 14	15363	SE Ohio and 90% West Virginia	Poor
<u>TRACE 2</u>			
Aug. 22	15405	NE Ohio, Lake Erie, and Canada	Poor
Aug. 22	15412	North from Salt Fork Lake	Poor
Aug. 22	15414	East of Columbus, North of boot	Poor
Aug. 22	15421	South of Ohio River boot	Poor
Sep. 9	15411	NE Ohio, Lake Erie, and Canada	Poor
Sep. 9	15414	East of Columbus	Poor
Sep. 9	15420	SE Ohio and Kentucky	Fair
Oct. 15	15413	NE Ohio, Lake Erie, and Canada	Very poor
Oct. 15	15415	East of Columbus	Fair
Oct. 15	15422	SE Ohio and Kentucky	Fair
Nov. 20	15420	NE Ohio, Lake Erie, and Canada	Very poor
<u>TRACE 3</u>			
Sep. 28	15465	Toledo and Detroit	Poor
Nov. 3	15473	NW Ohio, Lake Erie, and Toledo	Poor
Nov. 3	15480	Columbus, SW Ohio, and East Liberty	Fair
Nov. 3	15482	Southern Ohio and Kentucky	Very good
<u>TRACE 4</u>			
Aug. 24	15532	SW Ohio, Indiana, and Kentucky	Very poor
Aug. 24	15523	Toledo and area to the West	Poor
Oct. 17	15532	Western Ohio and Eastern Indiana	Poor
Oct. 17	15535	SW Ohio, Indiana, and Kentucky	Very good
<u>TRACE 5</u>			
Aug. 25	15582	Eastern Lake Michigan to Ohio	Fair
Sep. 30	15361	Eastern Lake Michigan to Ohio	Poor

* Quality relates to general cloud cover condition over area covered by satellite photography.

Although we are not as yet receiving ERTS-1 data within the 18-day period following the date of photography as originally planned, this has not had any detrimental effect on project progress. However, we are a little discouraged in terms of delays experienced in getting special ERTS data requests filled, particularly those involving color and IR composites. Also, many of the 70-mm negatives received have been too dense to permit printing good quality enlargements. The NASA decision to replace 9-1/2" x 9-1/2" black-and-white prints with 9-1/2" x 9-1/2" negatives will significantly benefit our program as we have a definite need for this product on a routine basis. Another data quality item of significance is that the ERTS-1 transparencies possess gamma variations which make repetitive feature density calibrations difficult.

B. Aerial Photography of Ohio-ERTS Study Sites

Initially, plans were to make an aerial underflight of the Ohio-ERTS study sites within one or two days following an ERTS pass. However, by late August some crops had been harvested and other crops and vegetation in general were in the later stages of their growing season. Accordingly, the decision was made to proceed with the initial aircraft underflights although cloud cover during ERTS-1 Ohio passes had prevented useful data from being acquired for the study sites. The Ohio Highway Department's twin-engine Beechcraft equipped with a 6" Zeiss RMK-A cartographic camera and with four Battelle 70-mm Hasselblads (with 100-mm planar lens) in a multiband configuration (see Figure 2) acquired photography for all study sites on August 29-30, 1972.

Black-and-white film (9-1/2" x 9-1/2") was used in the Zeiss camera. Kodak black-and-white panchromatic film was used in two of the Hasselblads, one with a Kodak 58B green filter, the other with a Kodak 25 red filter. Kodak Ektachrome TK S0117 film was used in one of the two remaining cameras, and Kodak Ektachrome ER Type 5257 was used in the other.

Flight altitude was 12,000 feet resulting in 9-1/2" x 9-1/2" format photography at 1:24,000 and 70-mm format photography at 1:48,000 scales.

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Figure 2. 70-mm Hasselblad Configuration Used to Acquire Aerial Multispectral Photography Over Ohio-ERTS Study Sites.

NASA Lewis (LeRC) acquired black-and-white 9" x 9" aerial photography of the Ottawa-Crane Creek study site in September 1972. The scale of this photography is approximately 1:10,000. Also, 35-mm Ektachrome aerial shots were taken on a selective basis during the photo flights of the Ohio aircraft.

Delays in acquisition of good (cloud-free) satellite imagery of study sites gave cause to include the Columbus-Franklin County area as an alternate study site for the land-use demonstration product. This selection was based on the availability of cloud-free ERTS-1 imagery and the fact that State of Ohio aircraft photography acquired in April 1972 existed for the area.

C. Study Site Ground Surveys

1. Photography and Radiometry

Ground-based photography of study site areas is almost exclusively 35-mm Ektachrome with some scenes supplemented with 35-mm color IR.

A Model SR ISCO spectroradiometer (see Figure 3) was determined to be capable of providing spectral data of value in analyzing ERTS imagery. An ISCO strip chart recorder made specifically for the SR spectroradiometer was ordered but, after delayed delivery was found not to be in acceptable working order. By the time its replacement arrived and calibration data were acquired for the radiometer, clouds, and sensitivity of the radiometer to temperatures below 50-60 F, it became necessary to delay spectroradiometric field work at study sites until spring 1973.

2. Photomapping

Aerial photography was used as a mapping base to map mainly samples of surface cover which should be identifiable in ERTS imagery. Types of cover were annotated on the aerial images. However, weather problems prevented acquisition of ERTS data until the photomapped surface scene had undergone very significant changes. This effort has also been discontinued for the winter season.

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Figure 3. ISCO Spectroradiometer Being Used to Acquire Spectral Signatures for Selected Study Site Features.

III. DCS/DCP EFFORT

The initial activity relating to the DCP aspect of the Ohio-ERTS project was the attendance of a Battelle staff member, representing the State of Ohio, at the ERTS Data Collection System Users Meeting, NASA Mississippi Test Facility, Bay St. Louis, Mississippi, on May 17-18, 1972.

During July the water quality monitoring installation located at the Battelle West Jefferson site was inspected and determined to be essentially in readiness for its planned use with the NASA-furnished DCP. The installation is comprised basically of a trailer-housed Schneider Instrument Company Model RM25A Robot Monitor. The Monitor is instrumented to sense seven water quality and five atmospheric parameters (see Figure 4).

Subsequently, a review was made of the air-quality monitoring equipment on hand at Battelle for use with the DCP. While the Schneider Robot Monitor is to be essentially continuously interfaced with the DCP, the air-quality instrumentation will be used on an ad hoc basis, as the experimental program and the specific availability of individual air-quality instruments dictate. The instruments that will be so used include the following:

- Bendix Series 8100 Analyzer (for monitoring NO, NO₂, NO_x)
- EnviroMetrics Inc. Series NS-200 SO₂/Nitrogen Oxide Analyzer
- Mast Development Co. Model 724-21 Detector (for monitoring strong oxidants)
- Union Carbide Model 3020 Air Quality Monitor (for monitoring CO, CH₄, and total hydrocarbons).

The DCP for the Ohio-ERTS project was received on October 23, 1972. Subsequently, the power supply and a set of amplifiers to interface the Schneider equipment with the DCP were fabricated. The antenna was erected adjacent to the trailer, and the DCP was installed. It was placed in operation on December 22, 1972 (see Figure 5).

Two problems have arisen with regard to the DCP. During the initial installation, it was found that the 60-cycle noise at the site was such that the

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Figure 4. Trailer-Housed Schneider Robot Monitor Unit Capable of Sensing Seven Water Quality and Five Atmospheric Parameters.



Figure 5. View of DCP Antenna Installation in Relation to Water Quality Monitor Trailer.

locally-fabricated amplifiers could not be used. Consequently, in order to test the transmission capability of the installation, the DCP was placed in operation without being interfaced with the sensing equipment. Therefore, no actual data have been transmitted to date.

The second problem has been vandalism or wind damage. The platform successfully transmitted for at least eight days, as evidenced by computer listing received to date. However, on January 8 inspection of the site revealed that the antenna cable had been torn from the antenna ground plane, thus disabling the platform. As yet the exact cause has not been determined.

The electromagnetic interference problem at the present site and the possibility of vandalism have given rise to renewed consideration of a change in the location of the DCP. The present site has been dictated by the fact that the Schneider water quality monitoring equipment, although trailer housed, is semipermanently installed. The site also is advantageous with respect to air-quality monitoring, in that it is nonurban and is located to the west of Columbus. This permits comparative nonurban and urban measurements to be made. Because of prevailing winds, some insight might also be provided as to the influence of nonurban areas to the west on the air quality in Columbus.

However, other considerations argue that the DCP installation be completely mobile. One is that water quality data at the present site is currently of no operational or research importance. More importantly, the Ohio-ERTS DCP is primarily intended to be a demonstration installation, and not a means of acquiring data for actual operational or research use. Therefore, it should be as accessible as possible to state activities having an interest in its potentialities.

To date, the semipermanence of the present installation has appeared to warrant the foregoing of a mobile platform. However, the difficulties recently experienced have changed this viewpoint. Therefore, the practicability of converting the installation to a completely mobile system is being assessed in detail. The probability is that this conversion will be made. Pending this decision, effort to complete the installation of the DCP at the present site is being suspended.

The possibility that the Ohio-ERTS platform might be made mobile has been discussed previously with Mr. J. Earle Painter. It is understood that this mobility would present no problems to NASA. Insofar as the Ohio-ERTS program is concerned, any delay experienced in establishing an operating platform installation will not

be significant. Because of distance the present site has been found to be inconvenient with respect to visits by interested state personnel. This inconvenience is amplified by the current winter season. Conversion, if made, will be completed by the time the latter factor ends.

IV. DATA ANALYSIS

A. Data Analysis Laboratory

Initial efforts involved preparing for a state of readiness to analyze ERTS-1 data. A special laboratory was constructed and equipment was selected and purchased. This included, as originally proposed, a 32-Color Spatial Data Systems Viewer (Model 703-32) and a Spectral Data Corporation Multispectral (Additive Color) Viewer System (Model 25) for ERTS-1 data analysis. A complete list of equipment can be seen in Table IV. Additional items are still being considered and purchased as the need for them arises. One such item is the Bausch and Lomb Zoom Transfer Scope.

The laboratory layout is such so as to permit the photointerpreter or investigator to access and view ERTS-1, aircraft, or ground-truth images from centrally located consoles. Cartographic data, sketches, photos, etc., are mounted on wall panels and movable easels. The central portion of the laboratory is shown in Figure 7.

B. Equipment Modifications

Modifications have been made and will continue to be made on various equipment items to make them more useful for ERTS data analysis. For example, the 32-color viewer has been outfitted with superior lenses for greater light transmission and higher magnification than was possible with the original optics. As a result, working photographic scales as large as 1:50,000 and 1:24,000 were achieved for certain terrain features. This required the ability to locate the features within an ERTS photo of some 10,000 square miles. Thus, a 9" x 9" x y comparator with motor drives and a one-minute reference grid was added. The TV camera settings were correlated in steps with map scales ranging from 1:500,000 to 1:24,000.

TABLE IV. EQUIPMENT CURRENTLY BEING USED ON THE OHIO-ERTS PROGRAM

	Type of Equipment	Manufacturer	Purpose for Which Equipment Was and Is Being Used
32-Color Viewer 703-32	Film density to color conversion*	Spatial Data Systems, Inc.	Qualitative & quantitative evaluation of ERTS imagery by converting densities to desired color
Multispectral Viewer Model 20	Image enhancement viewer	Spectral Data Corp.	Overlay of up to 4 ERTS images to produce color composites and to enhance specific image features
Multiple Interpretation Module (MIM)	Monocular and stereoviewing with up to 60X magnification & mensuration within $\pm .001''$ *	Richards Corp.	Viewing, comparison, magnification and mensuration of ERTS and aircraft imagery
Folding Mirror Stereoscope	Stereoviewing & plotting*	Wild Heerbrugg	Viewing & plotting of aircraft imagery
Microdensitometer	Density spot reading*	MACBETH	Precise density evaluation of ERTS imagery
35-mm & 70-mm rear projection systems	Special fabricated using Kodak & Bromberger projector*	Kodak, Bromberger, BCL	Rear projection of 35-mm & 70-mm data base for comparison viewing
Light tables	Film viewing*	Colight & others	Viewing & editing of film
Nistri Analytical Stereoplotter	Stereoplotting**, orthophoto map fabrication	Nistri-Bendix	Mapping & plotting from ERTS & aircraft photography
K&E grid digitizer	X Y plotter**	K&E	Mapping & plotting from ERTS or aircraft photography

* Located at BCL's Remote Sensing Applications Laboratory.

** Located at State of Ohio's Aerial Engineering Section Mapping Facility.

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Figure 6. Two Views of Battelle's Facility for Analyzing ERTS-1 Data.

C. Photographic Laboratory

Not included in the equipment listing of Table IV is a complete photographic laboratory for black-and-white and color photography which has been extensively utilized in the preparation of ERTS demonstration products.

D. Data Analysis Plan

Another major effort has been developing a workable plan to bring ERTS-1 imagery to the attention of State of Ohio users on a regular basis. This involves primarily two major analysis functions. First, there is the need to identify and catalog spectral, spatial, and temporal characteristics of selected (high-interest) natural and cultural features of Ohio. Second, analytical techniques and formats have to be developed for translating ERTS imagery to state user products.

The originally proposed data handling plan has been greatly elaborated in view of the intense interest for ERTS-1 demonstration products. ERTS-1 imagery is currently being handled in the following manner:

- (1) Of the three sets of photographic images received by the Ohio DECD, one is retained for possible reproduction by the Aerial Engineering Section of the Ohio Department of Transportation.
- (2) The Aerial Engineering Section produces 9-1/2" x 9-1/2" negatives and positive prints at a scale of 1:1,000,000 and 40" x 40" prints at a scale of 1:250,000. The prints are used as a part of the Ohio-ERTS Data User Handbook. The 40" x 40" prints are used for display and illustrations.
- (3) The remaining two sets of photographic imagery are cataloged at Battelle and correlated with earlier ERTS-1, aircraft underflight, and ground-truth imagery as well as radiometric data. The 70-mm and 9-1/2" x 9-1/2" transparencies are then viewed on the laboratory equipment in this order:
 - (a) Examination through high magnification and stereoviewing (where possible) to evaluate the quality of the imagery and to determine if areas of highest priority (such as the Ohio-ERTS study sites) have been successfully recorded.

- (b) Analysis on the multispectral viewer of areas or features of prime interest to determine to what degree these may be enhanced. This mode of viewing is also employed to view the same two bands taken at different dates for purposes of comparison to detect changes in time.
- (c) Analysis on the 32-color viewer to determine the characteristic density range of a feature of interest in all four ERTS bands through magnification and encoding of this density range into discrete colors. The feature thus enhanced is then recorded by its characteristic density. The characteristic controls on the instrument panels which enhanced the given feature are also recorded.
- (d) Areas of interest are then enlarged to scales of 1:250,000, and 1:125,000 and annotated with information to provide geo-coordinates, scale, and the most important features in the imagery. These 8" x 10" printed copies are then added to the imagery printed by the Aerial Engineering Section of the State of Ohio Department of Transportation, and 25 copies of this package are then forwarded by the DECD to various state users or state user agencies. Principal among these are:

The Ohio Department of Natural Resources which examines the imagery for strip mining, strip mining reclamation, flood plain management, and forestry applications.

The DECD users which evaluate the photography for land-use applications.

The Ohio EPA which has interests in ERTS imagery for land, water, and air quality control.

The Ohio Department of Transportation for the updating of orthophotomaps and map products.

OARDC (The Wooster Agricultural Experiment Station) which is interested in crop identification.

The Ohio State University Remote Sensing Committee which is interested in the educational aspects of ERTS imagery.

- (e) Investigators in the various user agencies report back to the Battelle Remote Sensing Applications Laboratory to further explore their specific interest. A more intensive study is then initiated. Usually one or more investigators of a specific user agency become directly involved by providing pertinent background information and working with Battelle personnel to find the solution to a particular problem.

- (f) The particular features are then accurately recorded by density and color, and a 35-mm and/or 8" x 10" black-and-white or color transparency and prints are then made from the viewer screens. These products are used to update maps, for feature comparison, fabrication of sketches and map overlays, and the fabrication of other demonstration products.

V. DATA UTILITY ASSESSMENT

Efforts in Data Utility Assessment have been aimed toward several objectives such as informing state resource management people of the existence and characteristics of ERTS data, soliciting suggestions as to possible additional uses of ERTS data, and the reception of comments and evaluation of ERTS imagery and products generated from ERTS imagery.

In order to facilitate input from state personnel who may be able to suggest additional uses for ERTS data in their area of expertise and involvement, ERTS data manuals have been prepared and are being distributed to key people with resource management responsibility throughout state government. These manuals contain a brief description of the ERTS system, its capabilities and sample uses, initially two different copies of ERTS images in Bands 5 and 7, and a questionnaire to be returned to the ERTS coordinator. These manuals will be updated from time to time with copies of the better ERTS imagery. The purpose of this manual will be to inspire further utility feedback and the identification of additional avenues to pursue in examining the utility of ERTS data.

In order to provide a vehicle for user evaluation of ERTS-related data, demonstration products in several application and/or problem areas are being prepared. Specifically, as reported in the last Type I status report, a strip-mine demonstration product illustrating the ability of ERTS to clearly delineate and inventory strip-mined lands has been completed. A follow-up is now being initiated in which the ERTS data will actually be used as the basis for developing initial plans and designing a new statewide reclamation program within the Department of Natural Resources to implement the recently enacted strip-mine control law in Ohio. In addition, other ERTS investigations in this area will be examined for implications to state enforcement and monitoring of reclamation efforts.

The strip-mine demonstration package also showed that ERTS could delineate the area and movement of some smoke plumes, which has resulted in a request from the Ohio EPA to examine the possibility of using ERTS data to test air movement models being developed for use in the statewide air pollution control program.

Another completed demonstration package contains enlarged and color enhanced photos showing sedimentation patterns in Lake Erie. Ohio EPA personnel are interested in testing this capability in conjunction with a current modeling effort that the EPA is working on in cooperation with people from NASA's Lewis Research Center.

A land-use demonstration product is currently being prepared for Franklin County involving several test scales. The effort is using the land-use classification scheme developed by the Department of Interior for remote sensing data. This study will be evaluated by state land-use planners in terms of the utility of these data to aid in formulating state land-use policy and making statewide land-use decisions; as to cost versus costs of previous studies using other means; and as to the extent to which trends in land use can be discerned as needed as a basis for new legislation.

In the area of user requests, in addition to those already discussed, a request has been made by the Department of Natural Resources to investigate possible uses in the area of floodplain management. This would involve determining to what extent ERTS images could be used to detect new developments encroaching upon the floodplain and from this the extent to which the repetitive nature of ERTS could be used to monitor the floodplain and enforce regulations.

In addition, city planners in Columbus and county planners in Clark County have expressed a desire to make use of ERTS images in their planning activities.

Another part of the utility assessment area has been the use of the Ohio-ERTS analysis at the Battelle facility in the real-time problem solving activities of state government personnel. This approach has been followed by the Department of Natural Resources in examining a soil erosion problem in Meigs County.

Plans for utility assessment in the future, in addition to continuing demonstration and evaluation activities, are to hold either one or a series of ERTS workshops for state resource management personnel to work as a group with ERTS data and to evaluate its apparent usefulness for the following functions:

- (1) Planning and decision making
 - (a) All levels and all time frames
- (2) Legislative needs
 - (a) Utility in definition and enforcement of state laws
 - (b) Utility in being responsive to federal legislation
- (3) Economic interests.

VI. SIGNIFICANT RESULTS

To date, only one significant result has been reported for the Ohio-ERTS program. This result, noted in the August/September 1972 Type I report, relates to the proven usefulness of ERTS imagery for mapping and inventorying strip-mined areas in southeastern Ohio. Thus, ERTS provides a tool for rapidly and economically acquiring an up-to-date inventory of strip-mined lands for state planning purposes which was not previously possible.

VII. MISCELLANEOUS

A survey of information items (reports, maps, circulars, brochures, bulletins, etc.) relating to Ohio environmental and natural resources interests potentially useful to Ohio-ERTS investigators and available at State, Battelle, and Ohio State Libraries has been completed. The survey lists available items by organizational origin, by discipline, and by location (i.e., county and/or study site).

State of Ohio and Battelle representatives attended the NASA meeting describing the preliminary findings from analysis of ERTS-1 observations held at GSFC on September 29, 1972, and selected sessions of the Eighth International Symposium on Remote Sensing of the Environment that followed. During the week of October 23-27, 1972, some ten State of Ohio and Battelle staff members participated in the remote sensing short course at The Ohio State University which was supported in part by the Ohio Department of Economic and Community Development. The course covered all aspects of the theory and practice of remote sensing of potential importance to the resource manager.

Some effort was expended during the first six months which was aimed at improving general public awareness of the ERTS program. This involved setting up numerous tours/visitations to the ERTS analysis laboratory at Battelle, preparing ERTS displays/exhibits, and making press releases. So far, over 100 visitors from industry, state agencies, and educational institutes have visited the laboratory. Figure 7 shows the exhibit describing the Ohio-ERTS program which was prepared for the Governor's booth at the Ohio State Fair (August 17-September 4, 1972). The exhibit also contained a short film describing the ERTS program and a pamphlet describing the Ohio-ERTS program specifically.

On December 21 a press announcement was made and a statewide news conference was arranged to describe Ohio's optimistic reaction to initial ERTS-1 imagery on Ohio. The conference demonstrated the ability of ERTS imagery to provide the means for detecting and mapping strip-mined areas in southeastern Ohio, detecting power-plant smoke plumes, and for providing the data necessary to compile up-to-date land-use maps for the entire state.

The contents of the press kit prepared for this conference are contained in the Appendix.

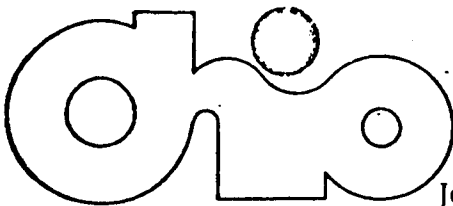


Figure 7. Ohio-ERTS Program Exhibit at the 1972 Ohio State Fair.



APPENDIX

OHIO-ERTS PRESS RELEASE ITEMS
PREPARED FOR STATEWIDE NEWS CONFERENCE
ON DECEMBER 21, 1972



John J. Gilligan, Governor / Dr. David C. Sweet, Director -Tel. 614/469-2609

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FOR IMMEDIATE RELEASE

COLUMBUS--"The post-Apollo era means down-to-earth solutions to Ohio's increasing environmental, natural resource and related development problems," according to Dr. David C. Sweet, director of the Ohio Department of Economic and Community Development.

"Ohio is making certain it harvests the tangible benefits of this new era and applies the results to more efficient management of the state's resources," he said.

Sweet today released the first Ohio photos taken in this new NASA developed series of unmanned satellites, the Earth Resources Technology Satellite (ERTS) program.

The photos are being intensively researched, said Sweet, and so far the initial results appear very promising for detecting and mapping strip-mined land, detecting sources of air pollution and mapping Ohio's land for long-term land use planning.

Sweet said the development department has primary responsibility for carrying out the study, which is funded through a \$215,674 grant from NASA for the Ohio/ERTS study.

He emphasized that the development department is one of the only two state agencies in the nation funded for such a project and is the only state agency taking what Sweet calls "a multi-disciplined, multi-agency approach" to the study.

"In fact, the development department was awarded the funding because it presented an integrated-approach proposal to NASA," he said.

The seven participating state agencies involved in assessing the state level resource management applications of the study are the departments of Economic and Community Development, Public Works, Health, Transportation, Agriculture, Natural Resources and the Environmental Protection Agency, along with the Ohio State University.

Organizations besides state agencies in 42 other states and groups in 31 foreign nations are participating in the ERTS program as well.

Research specialists at Battelle's Columbus Laboratories say that enough data is available from preliminary studies of the satellite photos to determine the definite utility of the photography, even though clouds have covered much of Ohio since ERTS-1 was launched July 23, 1972.

Battelle assisted the development department in drawing up the proposal for NASA funding and is providing extensive technical support to the project.

Although initial research results only cover the areas of strip-mine inventorying, power-plant smoke plume flow in the state, and surface land mapping applications, ultimately the photo data will be applied in three problem areas considered of major importance in Ohio:

- *Environmental Quality -- detecting air pollution levels, shore erosion and sedimentation, and monitoring strip-mine reclamation progress;

- *Agriculture and Forestry -- detecting crop conditions, projecting crop production levels, and helping conduct crop and timber surveys;

- *Geography -- updating Ohio's land use map (Ohio does not have a complete aerial map of the state for planning purposes), topical map preparation and orthophoto (space-photo) mapping.

The spacecraft is equipped with a device which produces color images in four wavelengths, two invisible to man. Since earthly subjects reflect light in different degrees, the satellite's sensory equipment is able to flush out heavily wooded areas or barren surface-mined areas, for example, from the rest of the landscape.

Researchers are using special photo translating equipment to study the imagery. By imposing colors, for example, they can detect, inventory and monitor Ohio's features.

The craft circles the earth in a near polar orbit, taking pictures of Ohio every 18 days. About four to six photos of Ohio produce enough imagery for an entire picture of Ohio.

"The ERTS program is a unique opportunity for Ohio state government to 'put its house in order' in terms of improving environmental, natural and man-made resource management," said Sweet.

"We're moving into the space-age with this program."

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State of Ohio
Department of Economic and
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A detailed illustration of a satellite in space. The satellite has a central body with various instruments and two large, rectangular solar panel arrays extending outwards. The background is a dark blue space with a curved horizon line at the top left, suggesting the Earth's surface.

SATELLITES FOR OHIO'S FUTURE

State of Ohio
John J. Gilligan, *Governor*

SATELLITES FOR OHIO'S FUTURE

"The Ohio satellite effort is a major step toward wise resource management necessary for balanced development in Ohio."

David C. Sweet, Director
Ohio Department of Economic and
Community Development

Ohio is entering the space-age with participation in a new satellite program designed to bring a better quality of life to Ohioans.

With the launching of the first satellite of the program on July 23, 1972 at Vandenberg Air Force Base in California, there is a greater chance that state authorities can detect dreaded concentrations of corn blight—measure air pollution levels—detect the urban sprawl strangling many cities—and determine whether strip-mine devastated land has been returned to its natural beauty.

WHAT CAN THIS SATELLITE DO FOR OHIO?

The basic function of the spacecraft is to photograph land areas. Ohio researchers will be using this photography to determine what useful environmental, natural and cultural resource information can be obtained. These people will also test the possibility of using the photographic data for future state environmental planning, monitoring and enforcement activities.

The Ohio satellite effort will concentrate on determining whether the satellite will be useful in three areas considered of major importance to Ohio:

- **Environmental Quality**—detecting air pollution, shore erosion and sedimentation, and monitoring strip-mine reclamation progress;

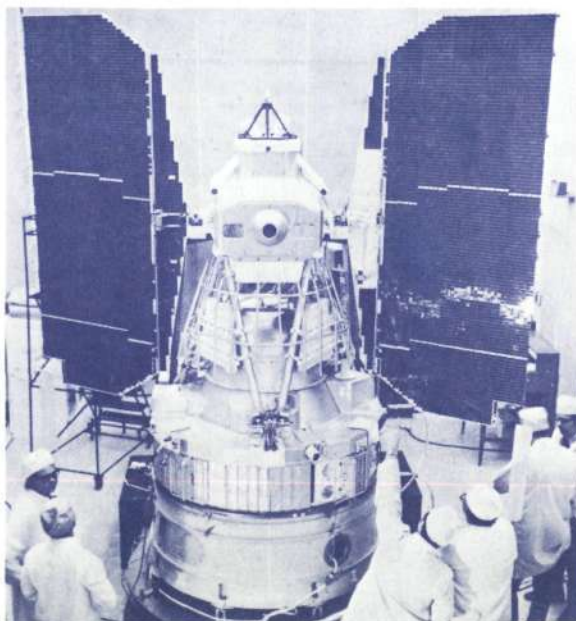
- **Agriculture and Forestry**—detecting crop conditions, projecting crop production levels, and helping conduct crop and timber surveys;

- **Geography**—updating Ohio's land use map (Ohio does not have a complete aerial map of the state for planning purposes), topical map preparation and orthophoto (space-photo) mapping.

HOW IS OHIO PARTICIPATING?

Ohio is taking part through a contract with the National Aeronautics and Space Administration (NASA). The contract is almost entirely funded by the federal government. Ohio was awarded this opportunity because it presented an exemplary proposal for involving several state departments in a multi-disciplined look at solving the state's environmental and natural resource problems. Participating along with 43 other states and 31 foreign nations, Ohio is one of only a handful of states to take this potentially more productive approach. Participating state agencies are: Public Works, Development, Health, Highways, Agriculture, the Environmental Protection Agency, and Natural Resources, along with The Ohio State University.

The development department will have primary responsibility for this NASA program.



The Columbus Laboratories of Battelle will provide extensive technical support.

HOW WILL THE SATELLITE WORK?

This satellite is part of the Earth Resources Technology Satellite (ERTS) program developed by NASA. A new series of unmanned satellites, ERTS is the first to study actual application of sophisticated space technology to the increasing environmental and natural resource problems on earth. By 1973, ERTS will be manned. ERTS 1 will orbit the earth for about one year photographing the same portion of the earth every 18 days. Four pictures of Ohio will capture enough land mass to make an integral picture of the state. Photographs of Ohio will be compared with ground data from five sites across the state representative of the three major problem areas. The sites are located near East Liberty, in Ottawa County, in Wooster, in the Zaleski State Forest and in the Cleveland-Lake Erie area.

State of Ohio
John J. Gilligan, Governor

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OHIO/ERTS PHOTOGRAPHY

FACT SHEET

The Ohio Department of Economic and Community Development, headed by Dr. David C. Sweet, has primary responsibility for carrying out this NASA-funded study aimed at testing the ERTS data applications for state resource management.

The initial images of Ohio taken by the first Earth Resources Technology Satellite (ERTS-1) have recently been received from NASA and are presently undergoing preliminary analysis by the State of Ohio and research specialists from Battelle's Columbus Laboratories.

Although an unusually high percentage of cloud cover has existed over Ohio since ERTS-1 was launched on July 23, 1972, and has limited the availability of useful photography to scenes of eastern Ohio, enough data are available to initiate preliminary studies of how such data may be used to help Ohio manage its resources and protect its environment.

These interim results are being made available under NASA sponsorship in the interest of early and wide dissemination of earth resources survey information.

ANALYZATION OF SPECIFIC PHOTOS

PHOTO 1:

From the initial review of several ERTS scenes taken of eastern Ohio in August, September, and October, such as the one (photo 1) taken on August 21, 1972, of the southeastern portion of the state, it has been experimentally shown that such photography can be used for accurately delineating and inventorying Ohio's strip-mined areas, detecting power-plant smoke plumes, as well as periodically providing the data necessary to compile up-to-date, land-use maps for the entire state.

The naked eye can clearly recognize larger, more prominent surface features such as those annotated on the ERTS-1 photograph. The satellite takes photographic-like images in four colors of light -- two visible and two invisible to the naked eye -- to highlight features routinely reflecting selected colors.

The sample ERTS scene of southeastern Ohio is a black-and-white representation of the orange-red visible light which was reflected from the earth's surface to the ERTS-1 sensors 500 miles above the earth. In this light, heavily wooded areas appear dark in comparison to man-made features such as highways and bare rock and soil areas void or stripped of vegetation.

PHOTO 2:

To maximize the use of ERTS-type photography requires the use of specialized image enhancement/interpretation devices. For example, another photo shows the rectangular area outlined in the photos of southeastern Ohio (covering some 10,000 square miles). It is enlarged to a scale of approximately 1 inch = 4 miles. The enlarged photo (photo 2) clearly demonstrates the extent to which strip-mined areas can be delineated in ERTS photography.

The center of the strip-mined area shown in photo 2 is in Muskingum County about 15 miles southeast of Cambridge, Ohio. The stripped area is characteristically lighter in appearance than the surrounding vegetation-covered area.

In the future, as this and other mined areas are revegetated, they will appear darker in subsequent satellite imagery, thus offering a potential means of quickly monitoring reclamation of strip-mined areas in Ohio.

Photo analysts use ground (on-site) photos along with aircraft photography to calibrate or verify their satellite data interpretation. Equipment used to analyze ERTS imagery can instantly (automatically) estimate the area involved in the mining operation. The sample area shown in photo 2, for example, is some eight miles long and is estimated to cover approximately 4,000 acres of land.

PHOTO 4 and 5:

An example of how ERTS photography can help provide state planners with a broad overview of land-use trends and developments can be seen in the sample enlarged photographs of various Ohio cities and counties showing major natural and man-made features (photos 4 and 5). Photo 5 illustrates how water features are highlighted in one of the colors.

As noted on the photographs, such man-made features as water reservoirs, airports, high-density urban areas, major highways, and agricultural patterns are quite prominent. Satellite data acquired of this same area five years from now, for example, when compared with this 1972 scene potentially offer a rapid means of determining and assessing changing patterns in land use.

OHIO AGENCIES PARTICIPATING

This early demonstration of the capacity of ERTS data to so clearly delineate strip-mined areas in Ohio is of interest to several state environmental, educational, and resource management activities.

For his own Department of Economic and Community Development, Dr. Sweet plans to use the ERTS land-use mapping capability in a state-wide land-use planning program to provide for orderly growth and development which also takes natural resource considerations into account.

A detailed study of the inventorying abilities of ERTS-1 using a five-county sampling site in the southeastern part of Ohio is being performed by Dr. Wayne Pettyjohn of the Ohio State University. His study, under a separate NASA contract, will also consider the usefulness of ERTS data for studying and monitoring environmental/ecological effects produced by strip-mining operations such as surface erosion and vegetation and mine-acid drainage effects.

Ohio's Department of Natural Resources is interested in the implications of these early findings and possible future ERTS accomplishments to several pressing state problems. In particular, Ernest Gebhart, Chief, Ohio Division of Forestry and Reclamation, sees ERTS as a potentially valuable tool for assisting his office in evaluating requests for mining permits (over 300 per year), and in enforcing the recently passed Ohio strip-mine bill after permits are granted.

Similarly, Terry Wakeman, Manager of Ohio's flood-plain program, is looking at ERTS capabilities from the standpoint of assisting his staff in monitoring flood-plain developments throughout the state--a major problem if Ohio decides to pass legislation requiring state-wide regulation of flood plains.

The significance of ERTS imagery to reveal smoke plumes such as that emanating from a power plant on the Muskingum River (as shown in the second photo) is being determined by personnel from the state's newly established Environmental Protection Agency. Specifically, the operational usefulness of such periodic and synoptic plume detection capabilities provided by ERTS-1 to state-wide air (pollution) motion pattern studies is being evaluated.

ERTS PHOTOS CITED IN FACT SHEET

- PHOTO 1. ERTS-1 photograph of whole scene.
- PHOTO 2. Enlargement showing strip-mined areas.
- PHOTO 4. Enlarged section of ERTS photo, showing Columbus and surrounding counties in the color emphasizing man-made (cultural) features, highways, airports, buildings, etc.

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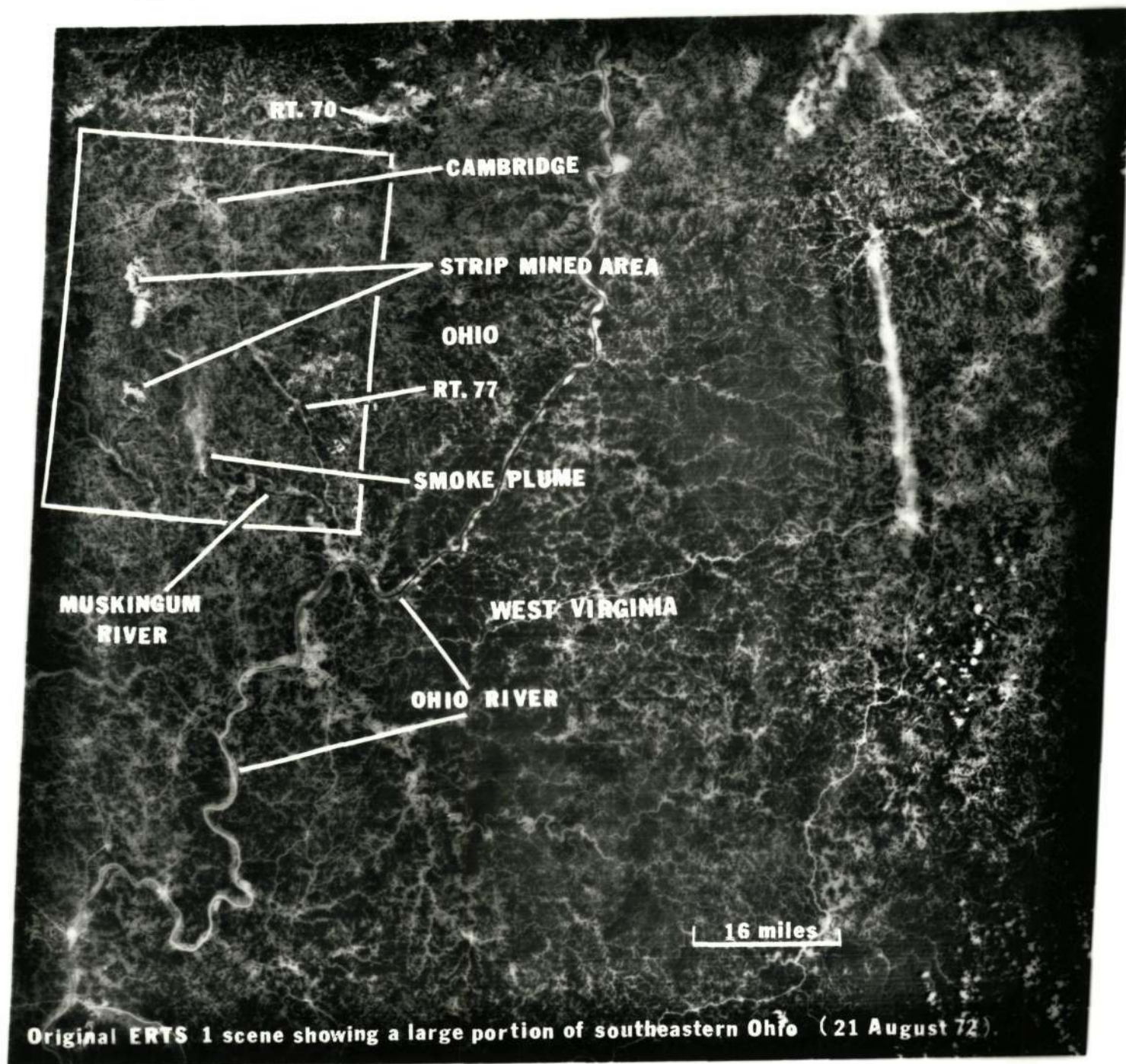


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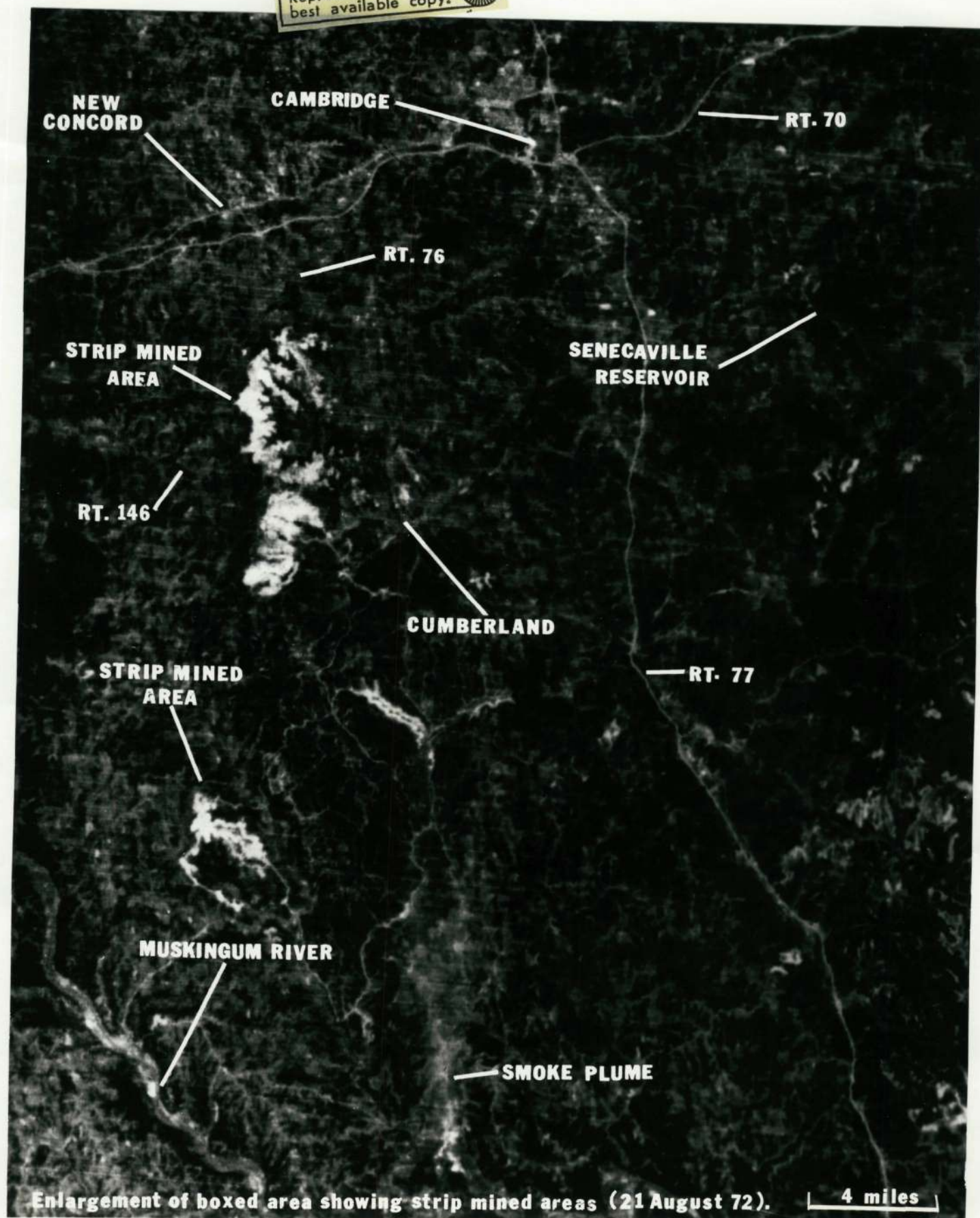
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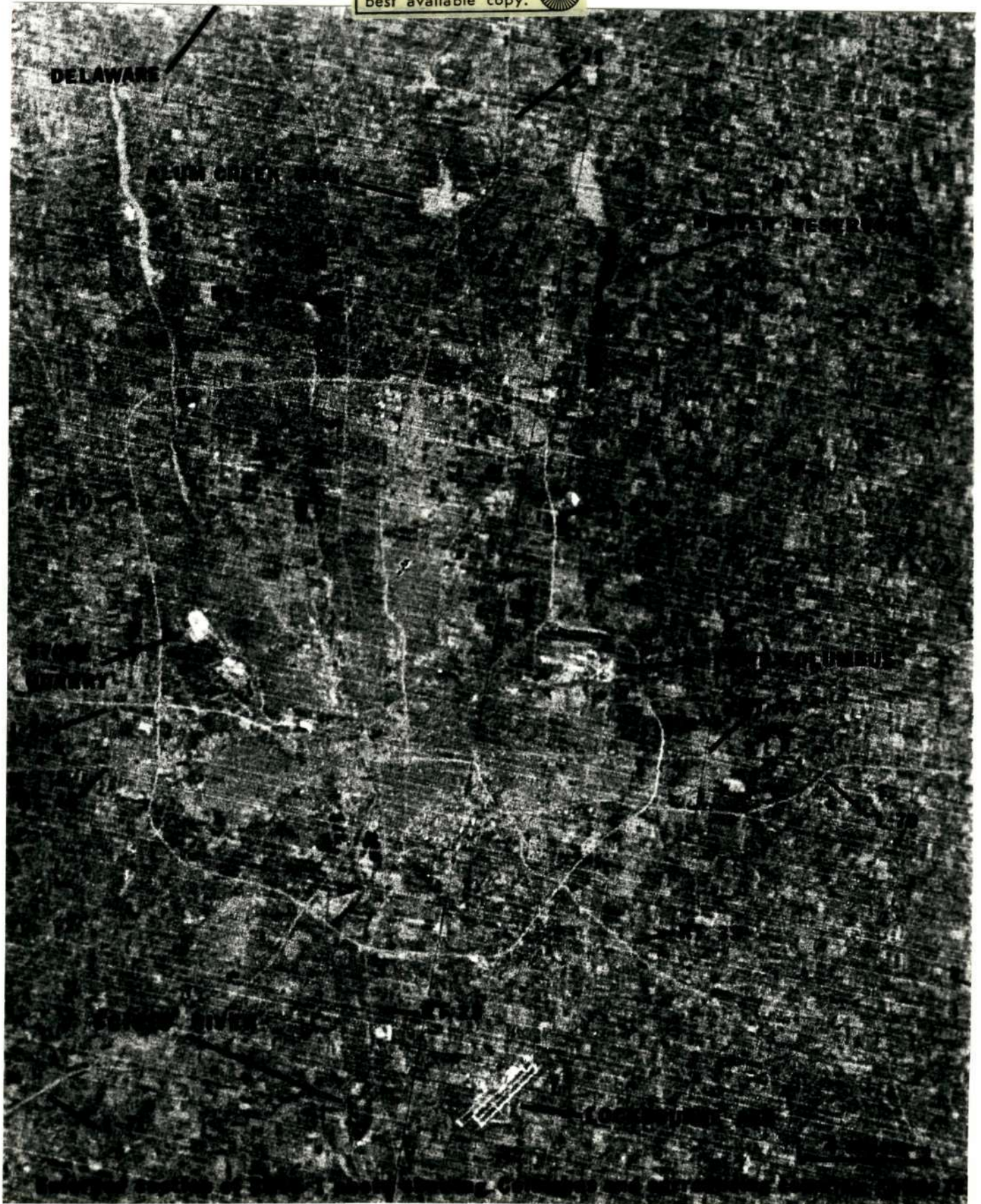


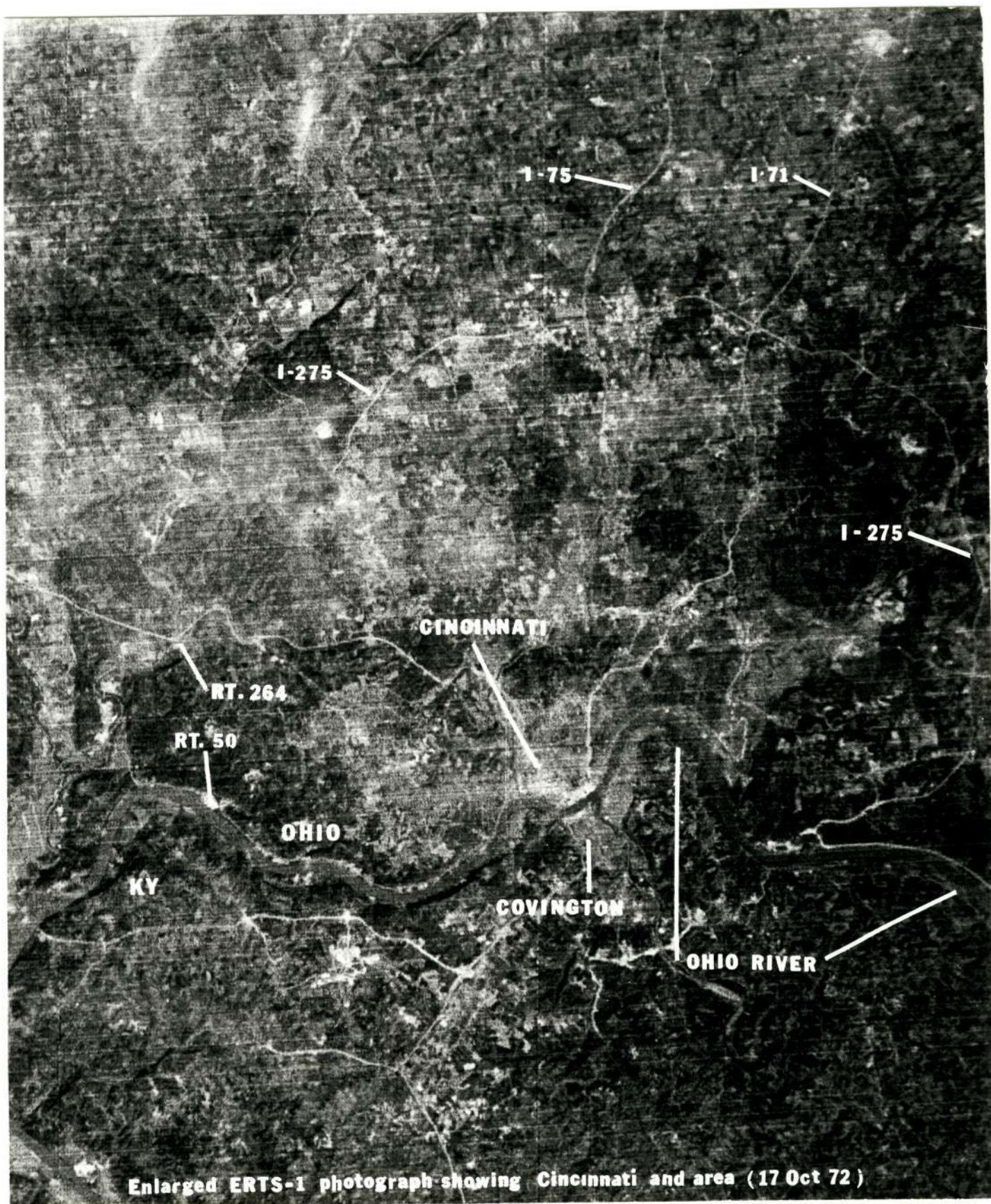
Original ERTS 1 scene showing a large portion of southeastern Ohio (21 August 72)

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Enlarged ERTS-1 photograph showing Cincinnati and area (17 Oct 72)